

A REVIEW OF THE SEQUENCE OF *BUCHIA* SPECIES IN THE JURASSIC OF AUSTRALASIA

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The complete sequence of those species of the aviculo-pectinid genus *Buchia* Rouillier (= *Aucella* Keyserling) which occur in the late Jurassic of New Zealand has lately been described by Fleming and Kear (1960). Earlier, Fleming (1959) had taxinomically revised *Buchia plicata* (Zittel) and some of its allies. Among the latter he gave the first description (Fleming 1959, pp. 896-898) of *B. aff. B. blanfordiana* (Stoliczka) from the Jarlemai Siltstone in NW. Australia (Canning Basin) which I had some years ago (Brunnschweiler 1954) provisionally assigned to *B. spitiensis* (Holdhaus) and *B. extensa* (Holdhaus).

After Fleming's description one will certainly agree that the Jarlemai species belongs to the group of *B. blanfordiana*. Less likely, however, is the conspecificity of this *blanfordiana*-group, and of *B. aff. B. blanfordiana* (Fleming 1959) from the Jarlemai Siltstone in particular, with *B. plicata* as Fleming (1959, p. 896) suggests chiefly, I suspect, because he believed the two species to be coeval (Lower Tithonian—Brunnschweiler 1954). However, the presence of giant ammonites of the genus *Perisphinctes* s. str. has since proved that the Jarlemai Siltstone is much older, namely upper Oxfordian (Brunnschweiler 1960).

Conspecificity of *B. blanfordiana* with *B. plicata* would therefore imply the existence of a very long ranging species among the Australasian representatives of the genus, i.e. a species that would be useless as a zone fossil. However, as Fleming (1959, p. 896) points out, there are distinct enough differences between these forms. In view of the considerable age disparity these differences assume renewed significance. It seems now noteworthy again that only Trechmann (1923) ever went so far as to claim New Zealand specimens to be *B. blanfordiana* proper; all other authors insisted that *B. plicata* possesses sufficient morphological peculiarities to be retained as a clearly separate species. Since the correct age of the Australian form has been revealed it is no longer surprising that in New Zealand only one of the two species, i.e. *B. plicata*, occurs. Evidently, *B. blanfordiana* is an Oxfordian species, and marine formations of Oxfordian age are believed to be absent from New Zealand (Fleming and Kear 1960).

After these introductory remarks pertaining to Australian and New Zealand species it seems rather interesting to go farther afield and survey the situation in Australasia as a whole. Such a revision of the age and sequence of *Buchia* species between Himalaya and New Zealand would largely be dependent on the existence of reliable regional zoning by ammonites. Unfortunately, this is a somewhat weak point. It has been realized for some time that, for instance, the stratigraphy of the Himalayan Jurassic is in need of modern re-analysis. Under the prevailing circumstances, however, there is little hope that such work (which must include careful re-sampling of famous type sections such as those in the Spiti Valley) can be carried out in the near future.

The classical Himalayan faunas of the Upper Jurassic are thus likely to retain their sequential vagueness for some time to come and remain, except for broadly

generalized correlations, poor reference material. No wonder then that, in fact, correlation procedures have in recent years been reversed so that with the help of faunas from other Jurassic localities in S. Asia and Australasia corrections to the Himalayan sequence have boldly been attempted (Arkell 1957; Fleming and Kear 1960, pp. 32-33 and 36-37). Such attempts are certainly interesting and worthwhile even if the resulting amendments must remain tentative until they have been checked against the true stratigraphical record contained in the classical (although sequentially incomplete) Spiti Series, or then, failing that, against the record found in a newly discovered and less inaccessible locality in the Himalayan faunal region which will yield most or all of the genera and species known from the Spiti shales.

At this stage the attempted corrections have affected only a small, although important section of the large Spiti faunas. Ammonite genera such as *Kossmatia* and *Parabolicseras*, for example, are now believed to have arisen as early as lower and middle Kimmeridgian times (Arkell 1957), whereas they were previously thought to be restricted to the Tithonian. At present the evidence for this radical change rests still entirely on the interpretation of the strongly folded Upper Jurassic sequence at Kawhia Harbour in New Zealand (Fleming and Kear 1960); an interpretation which, although reasonable enough, does not seem to be altogether unshakable in view of the often very cautious wording of the relevant statements made by these New Zealand authors. Before the new dictum can be unreservedly accepted it seems advisable to see it further checked, if not against the currently inaccessible Spiti sequence, then against the well zoned and more complete Upper Jurassic series of Mexico (Burckhardt 1906, 1912, 1930) which is even richer in ammonites (including *Kossmatia*). The sequence reported now from New Zealand is certainly at variance with that found in Mexico. It may also be recalled that Heim and Gansser (1939) who studied the Spiti shales in the Kumaon region, i.e. SE. along the strike from the Spiti area proper, came to the conclusion that their age is chiefly Portlandian and/or Tithonian, although basal beds of the 'series' have in some places also yielded Oxfordian ammonites such as *Mayaites*, *Epimayaites*, and *Grayiceras*. Since the Himalayan representatives of the genera *Kossmatia* and *Parabolicseras* are known to occur only in the upper levels of the Spiti shales the balance of the evidence still favours a post-Kimmeridgian age for them. In fact, there has never been direct evidence of Kimmeridgian in the Spiti shales.

On reviewing all *Buchia* species recorded from Australasia, and paying particular attention to those among them which occur together with clearly age-determining ammonites, one arrives at the following conclusions and/or conjectures (see also Table 1):

(1) *B.* aff. *B. blanfordiana* (Stoliczka) from the Jarlemai Siltstone in NW. Australia (Fleming 1959) occurs together with *Perisphinctes* (? *Perisphinctes*) sp. aff. *P. cautisignare* Arkell (Brunnschweiler 1960). Its first appearance is therefore in the upper Oxfordian. It may range into the Kimmeridgian but does not seem to be present in the possibly early Kimmeridgian '*Buchia* beds' (*subpallasi-subspitiensis* group) encountered in the artesian bores at Broome and near Derby (Teichert 1940, 1942).

(2) *B. blanfordiana* (Stoliczka) from the Spiti shales is said to have come from above the basal 'belemnite beds' of that series (Uhlig 1910). This would mean that it is a post-Oxfordian species. In fact, the exact provenance of this species is not known, and in view of its very close affinity to the form from NW. Australia it may yet well be an upper Oxfordian species.

(3) The exact stratigraphical position and sequence in the Spiti shales of *B. spitiensis* (Holdhaus) and similar forms such as *B. extensa* (Holdhaus), *B. grandis* (Holdhaus), and *B. superba* (Holdhaus) again are not known. Whether they are representatives of a single variable population as suggested by Holdhaus (1913) and Fleming (1959) remains questionable. In the light of paragraphs (1) and (2) above it may be significant that *B. superba*, as Fleming (1959) points out, is much more like *B. blanfordiana* than *B. spitiensis*. The fact that a collection, as in this case, was made at a single locality (Chidamu) does not preclude the possibility of fossils from several stratigraphical levels having been thrown into the same sample bag as 'a population'. It is precisely that sort of thing which vexes discussions about the Spiti sequence in general. Under these circumstances there is a possibility that *B. superba* may be Oxfordian, the others Portlandian and/or Tithonian.

(4) The East Indian species *B. subspitiensis* (Krumbeck) and *B. subpallasi* (Krumbeck) were believed to be of lower Oxfordian age from correlations based on belemnites belonging to the group of *Belemnopsis gerardi* Oppel. These correlations are acceptable only with reservations (Teichert 1940). The relationship of the beds containing *Buchia* with those containing the ammonites *Epimayaites* (of Oxfordian age) and *Uhligites* (Kimmeridge/Tithonian) mentioned by Böhm (1905, 1907, 1910) is uncertain. It is, in fact, as Teichert (1940) showed, very likely that the 'Aucellen-Sandstein' of Misool, which is characterized by the *subspitiensis-subpallasi* group, belongs with the Kimmeridgian, not the Oxfordian.

It seems significant that in NW. Australia, which in this context surely belongs to the East Indian faunal province, the genus *Buchia* does not appear before the upper Oxfordian, although a richly fossiliferous sequence (Alexander Formation—Brunnschweiler 1954) of probably lower and middle Oxfordian age (not Kimmeridge to Tithonian as I thought in 1954) is present.

(5) *B. malayomaorica* (Krumbeck) in the East Indies, and the identical or very closely related form in NW. Australia, are certainly younger than the *subspitiensis-subpallasi* group, however similar the latter may be to New Zealand's *B. plicata*. This means, as was pointed out earlier (Brunnschweiler 1951), that *B. malayomaorica* in spite of its well developed radial shell ornament is not an 'archaic' species of the genus as had been concluded, firstly, by analogy with the sequence of species in the boreal province and, secondly, from what appeared to be a confirmatory sequence in New Zealand. In fact, the latter species series only shows that the widespread *B. malayomaorica* (Kimmeridgian) precedes the local *B. plicata* (Tithonian). The series simulates that of the boreal regions because, in the absence of Oxfordian (Fleming and Kear 1960), the appearance of *plicata*-like lineages well before *B. malayomaorica* cannot be demonstrated in New Zealand.

The range of *B. malayomaorica* still poses a problem. In the East Indies and in New Zealand it is clearly restricted to the Kimmeridgian; in Australia it has been found in a formation (Langey Beds—Brunnschweiler 1951, 1957, 1960) which contains *Calpionella* Lorenz and the ammonite *Kossmatia* cf. *K. tenuistriata* (Gray), both typically mid-upper Tithonian guide fossils. When considering this problem the following points must be kept in mind:

- (a) The infusorian *Calpionella* is not known to occur before the Tithonian.
- (b) In spite of the doubts expressed above it cannot be flatly denied that the genus *Kossmatia* could have originated already in the early Kimmeridgian in the New Zealand region and only later spread into other parts of the

Tethys. After all it is hardly likely that Arkell (1957) with his great knowledge and experience should have reclassified *Kossmatia* without reasonable evidence—even if this evidence was going to be presented in such guarded terms as in Fleming and Kear (1960).

- (c) Some species of *Kossmatia*, especially when the identification has to be made on fragmentary specimens, may be indistinguishable from a Kimmeridgian *Idoceras* of the *humboldti*-group. Compare e.g., *Idoceras minutum* Dieterich in Ziegler (1959, Pl. I, fig. 8) with the fragment of *Kossmatia* cf. *K. tenuistriata* in Brunnschweiler (1960, Pl. I, fig. 4).
- (d) The *Buchia* species in the Langey Beds may not be the true Kimmeridgian *B. malayomaorica* but a new Tithonian homoeomorph, the distinguishing characters of which are not observable on the poorly preserved material available and figured in Brunnschweiler (1960).
- (e) In spite of phenotypic 'overlaps' the evolutionary pattern of the genus *Buchia* in general does not show any truly long ranging species. It seems therefore not justified, at least not on the meagre evidence from Australia alone, that *B. malayornaorica* should be regarded as an exception to the rule.

Until better preserved fossils from the Langey Beds become available it seems advisable to accept point (a) as the most decisive. It follows that there is no need to bother about (c), and that the identification of the Langey Bed's *Kossmatia* cf. *K. tenuistriata* (as confirmed by the late Dr W. J. Arkell) remains essentially correct. Consequently, keeping in mind (e), one may then accept point (d) and revise the identification of the *Buchia* from the Langey Beds (Brunnschweiler 1957, 1960) to read *Buchia* ? n. sp. aff. *B. malayomaorica* (Krumbeck).

(6) The exact position of the post-Oxfordian *B. misolica* (Krumbeck) with regard to the East Indian occurrences of the ammonite *Uhligites* is not known. However, in New Zealand *B. misolica* has been found in the lower Tithonian together with *Uhligites motutaraensis* (Böhm), *Aulacosphinctoides brownei* (Marshall), *A. marshalli* Spath, *A. sisyphi* (Hector), and an as yet undescribed species of *Kossmatia* (Fleming and Kear 1960).

(7) From the Tithonian of New Caledonia (La Foa Formation—Pirouet 1917) there is a record of *B. leguminosa* (Sokolov), but its relationship to other Australasian forms has not yet been investigated. It belongs most likely to the *plicata*-group.

(8) *B. plicata* (Zittel) and *B. hochstetteri* Fleming are so far known only from New Zealand where they occur in the lower Tithonian together with *Aulacosphinctoides brownei* (Marshall), *A. marshalli* Spath, *A. sisyphi* (Hector), *Uhligites motutaraensis* (Böhm), etc. (Fleming and Kear 1960).

Buchia is a characteristic and common fossil in the Australasian Upper Jurassic but it disappears from that region before the dawn of the Cretaceous. In the Boreal Province it persists into the late Neocomian. Thus the genus not only originated in the Boreal Province, but it also found its last refuge there.

During the Aptian *Aucellina Pompeckj* appears which, in spite of its belonging to the same family and its great phenotypic similarity to *Buchia*, is a phylogenetically independent offshoot, probably (like *Buchia* itself) from *Meleagrinnella* Whitfield (Brunnschweiler 1959).

While it was unavoidable that several questions would remain unanswered the review nevertheless shows the main outlines of an overall sequence and pattern in

TABLE 1

Occurrences of Australasian Species of *Buchia* in relation to those of Important Ammonoid Genera

BUCHIA SPECIES		Oxfordian			Kimmeridgian			Tithonian		
? n. sp. aff. <i>malayomaorica</i>	AU									
<i>plicata</i>	NZ									
? <i>plicata</i> (cf. <i>leguminosa</i>)	NC									
<i>hochstetteri</i>	NZ									
cf. <i>plicata</i>	NZ									
aff. <i>misolica</i>	NZ									
<i>misolica</i>	EI									
<i>grandis</i>	HM									
<i>extensa</i>	HM									
<i>spitiensis</i>	HM									
cf. <i>subspitiensis</i> (2)	EI									
<i>malayomaorica</i>	EI									
	NZ									
cf. <i>subspitiensis</i> (1)	EI									
cf. <i>subpallasi</i>	EI									
<i>subspitiensis</i>	EI									
	AU									
<i>subpallasi</i>	EI									
	AU									
<i>superba</i>	HM									
<i>blanfordiana</i>	HM									
aff. <i>blanfordiana</i>	AU									
AMMONOID GENERA		lower	middle	upper	lower	middle	upper	lower	middle	upper
<i>Aulacosphinctoides</i>	NZ									
<i>Blanfordiceras</i>	HM									
	NG									
<i>Kossmatia</i>	HM									
	NG									
	AU									
<i>Paraboliceras</i>	NZ									
	HM									
	NG									
<i>Uhligites</i>	NZ									
	HM									
	EI									
<i>Idoceras</i>	NZ									
<i>Aspidoceras</i>	NZ									
<i>Subneumayria</i>	NZ									
<i>Epicephalites</i>	NZ									
<i>Grayiceras</i>	HM									
<i>Mayaites</i>	HM									
<i>Epinmayaites</i>	HM									
	EI									
<i>Perisphinctes</i> s. str.	NG									
	AU									

LEGEND

HM = Himalaya (Spiti, Kumaon)
 EI = East Indies (Timor to Celebes)
 NG = New Guinea
 AU = Australia (Northwest)
 NC = New Caledonia
 NZ = New Zealand (North Island)
 ————— = certain - - - - = suspected
 [shaded box] = Stage absent

SOURCES OF INFORMATION

HM: Uhlig (1910), Holdhaus (1913)
 EI: Krumbek (1923, 1934), Wandel (1936), Teichert (1940), Böhm (1905, 1907, 1910)
 NG: Schlüter (1928), Australasian Petr. Co. (1961), Glaessner (1945)
 AU: Teichert (1940), Brunnschweiler (1954, 1960), Fleming (1959)
 NC: Piroutet (1917)
 NZ: Fleming (1959), Fleming and Kear (1960)

the evolution of *Buchia* in the Australasian Jurassic. It also illustrates the difficulties (in this case both with *Buchia* and *Kossmatia*) palaeontologists encounter when they have to base their dictum on species and species groups which, although characterizing stratigraphic levels millions of years apart, have so many features in common that they are almost impossible to separate unless very well preserved specimens are available for study.

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